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DERSLİK VE LABORATUVARLAR İÇİN RFID & BLUETOOTH KONTROLLÜ İKLİMLENDİRME SİSTEMİ (1)

RFID & BLUETOOTH CONTROLLED AIR CONDITIONING SYSTEM FOR CLASSROOMS AND LABORATORIES

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Öz: Amaç: İklimlendirme, okul ortamlarında öğrenci ile öğretim elemanı sağlığı ve eğitimin verimliliği açısından oldukça büyük bir öneme sahiptir. Derslik ve laboratuvarların iklimlendirmesi için çoğu kez klimalar tercih edilmektedir. Klimaların yüksek enerji tüketimi eğitim kurumları için ciddi bir maliyet oluşturmaktadır. Kapatılması unutulmuş klimaların dersliklerde saatlerce gereksiz yere çalışması enerji kullanımını arttıran unsurlardan biridir. Bir diğer unsur ise uygun dış ortam sıcaklığına rağmen klimaların yine gereksiz yere çalıştırılmasıdır. Bu gereksiz harcamaların akıllıca yaklaşımlar ile kısıtlanması Arduino kontrol kartları ile mümkün olabilmektedir. **Yöntem-Bulgular**: Bu çalışmada salon tipi 3 fazlı bir klima, RFID kart ve Bluetooth teknolojisi ile iç ve dış ortam sıcaklık değerini ölçen sensörler yardımıyla Arduino platformu üzerinden kontrol edilmiştir. **Sonuç**: Bu sayede klimanın kontrolü RFID kartı veya mobil cihazı kullanan öğretim elemanı tarafından yapılabilmekte ve gereksiz enerji harcamalarının önüne geçilebilmektedir.

Anahtar Kelimeler: Arduino, RFID, DHT-22, Klima, RemoteXY

Abstract: Aim: Air conditioning has a great importance for the health and productivity of instructors and also for the students in the school environment. Air conditioners (ACs) are often preferred for air conditioning of classrooms and laboratories. High energy consumption of these ACs raises costs to educational institutions. Forgetting to turn off the ACs at nights or weekends also causes high energy waste and motor failures. Another factor rising costs is to run the ACs while outside temperature is adequate and there is no need to run the ACs. **Method-Results**: To overcome these situation, Arduino based control systems may be used. **Conclusion**: In our study, an HVAC is controlled via the Arduino platform. We used RFID and Bluetooth technology to prevent unauthorized access to the unit controls while checking indoor and outdoor temperature to decide whether it is really necessary to run the ACs to avoid the unneeded startup.

Key Words: Arduino, RFID, DHT-22, Air Conditioning, RemoteXY

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INTRODUCTION

Air conditioning is a system for controlling the humidity, ventilation, and temperature in a building or vehicle, typically to maintain a cool atmosphere in warm conditions. Air conditioners (ACs) are machines; provide heating, cooling, air cleaning, air circulation and keeping the amount of moisture at a certain level. Starting with primitive solutions in the years of 1500, air-conditioning has been an indispensable climate solution for people with different forms and working methods. ACs differ according to their working environment as indicated in the following; 1- Wall type split, 2- Saloon type split, 3- Ceiling type split, 4- Floor type Split and 5- Window type split as shown in Figure 1 (Anonymus, 2007: 8).

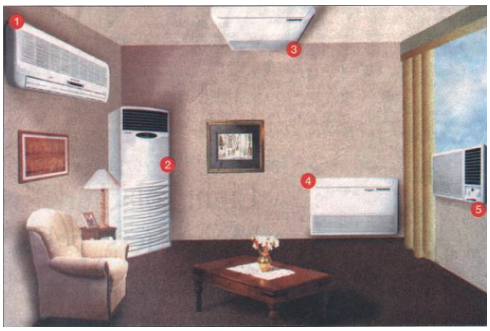

Figure 1. Air Conditioners Type (Anonymus, 2007:8)

According to globally accepted standards, the comfort environment for humans is 20-27 °C temperature and 30% - 60% humidity range. If the temperature of the environment we are in is more or less than the comfort temperature that should be, it can cause complaints such as throat instability and burning in the eyes. Similarly, excessive moisture can cause a feeling of sweating and overwhelming warmth (Tezcan M.K, 2010: 16).

Because of these reasons, ACs are frequently used in educational institutions. It is important to keep the air of the classrooms and the laboratory environments where the students and the instructors are in the comfort conditions, as well as the lecturers and the lecturers who teach the course (Uludağ Z. and Odacı H. 2002: 2).

Because of the comfort they provide, the high-powered saloon type split causes serious electricity costs due to their long-term operation. Forgotten turn ACs off at the end of the lesson and working in classrooms for hours and hours unnecessary is one of the elements that increase energy consumption at educational institutions. In order to prevent energy wastage, it is necessary that the air conditioners can be operated by teaching staff during the course of the lesson. However, this situation can be achieved with the sensitivity of the teaching stuff. In schools with many classrooms and laboratories, it is very difficult to follow this situation. Especially in universities where the class times are flexible, the follow-up becomes even more difficult.

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Another factor that causes energy waste is that the air conditioners are operated unnecessarily even though there is a suitable ambient temperature. With the opening of the windows, the fresh air to enter will make the lesson more efficient because it will provide oxygen enrichment for the brain.

The two problems mentioned above provide the motivation for this study. A control card needs to be designed to get over the problems involved. The controller unit at the heart of the control board must have the ability to communicate with the peripheral units and produce a specific result after evaluation. This can be achieved with the program to be installed on the controller chip.

PREVIOUS STUDIES

In the work done by (Yakar R. & Köklükaya E., 2001), PIC16F84 (manufactured by Microchip) microcontroller was used to control the devices by telephone. The control card circuit and the operation of the program were explained in their study.

(Sefa İ. and Kahraman H. T., 2007) have focused on providing energy saving and ensuring the comfort of the environment at a higher level. The existing climate control systems detect the ambient temperature with the temperature sensor on the air conditioner. With a point measurement, it is not possible to establish an equal comfort in a whole climate zone. In this study, an approach called "Multi Point Temperature Measurement" is presented to increase ambient temperature comfort in air conditioning. In the climate, the PIC18F452 processor is used as a controller and it communicates with radio frequency (RF) modules with temperature measurement modules at distant points. Functions such as programmability, sleep, auto tuning, fan speed and blowing angle control can be performed via an infrared (IR) communicating remote control, and status information can be displayed on a liquid crystal display (LCD) on the air conditioner.

Automatic control of air conditioning for vehicles was discussed by (Tezcan M.K., 2010). In this study, the automatic control design for vehicle's air conditioners were examined by using a programmable microcontroller instead of mechanically controlled. In order to overcome the adverse conditions arising from meteorological factors in most of today's vehicles, a combination of heating (heating) and cooling (air conditioning) systems are used. The SHT-11 humidity and temperature sensor measures the temperature in the vehicle, the DS1820 temperature sensor measures the temperature outside the vehicle, and the received data is processed by the PIC18F452 microcontroller. In addition, the measured values and other parameters can be displayed on the LCD screen and the fan speed setting,

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air direction control and indoor / outdoor air control can be electronically controlled.

An air conditioning system was controlled by programming a PIC microcontroller with a fuzzy logic system at (Erkaymaz H., and Çayıroğlu İ., 2010) studies. The system keeps the temperature of its environment at 19-23°C. As input variables, humidity and temperature values are taken from outside by SHT11 sensor and transferred to PIC 16F876 programmed with fuzzy logic system. Depending on the output values, the heater heats up and the cooling fans are operated to provide the necessary air conditioning.

In Turhan E. S. et. al. (2014) study, a universal controller connected to the Arduino (a microcontroller platform) was controlled via the web interface. In this way, it was possible to control any device found in the room from a different place. Internet connection and an Arduino were used in the venue to adapt the study to the existing devices. An example of an application is the reference to the operation of an air conditioning system.

MATERIALS and METHOD

It is necessary to design a control card to get over the problems mentioned in the introduction. Several different structures can be used as controllers in the control card design. The first is to design a microprocessor-based control card. However, microprocessor systems require many external components, such as an input / output (I/O) unit, memory (RAM, ROM, EEPROM, etc.), oscillator, supply and reset unit along with a microprocessor. When these units are received separately, they occupy space on the control card and increase the cost of the control card. Microcontroller based control cards are often preferred due to their low cost. For this reason, a microcontroller control card may be preferred instead of a microprocessor control card.

Since I/O units and memory units of microcontroller systems are located in the microcontroller chip, the system design will benefit both from the area covered by the electronic control board and from the cost side (Altınbaşak O., 2000: 16). However, a programming card is needed to program microcontrollers. This means additional system cost. However, the use of Arduino platforms instead of using a microcontroller alone provides advantages both in terms of space and cost. In addition to the microcontroller on Arduino platforms, the presence of units such as programming, serial communication, power supply, and reset circuits facilitate the design of the control card from the point of view of the designer and reduces the cost of the control card design (Banzi M., 2011: 17-19). For these reasons, Arduino platform is preferred as controller unit in control card design.

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The appropriate program for the microcontroller on Arduino platform is installed. This program means system software. The Arduino platform, which will communicate with environmental units, will need sensors to transmit the temperature and humidity information of the internal and external atmosphere. Because of this perception, the Arduino platform will decide whether the outdoor temperature is suitable for operating the air conditioner. In addition, it is also necessary for an authorized person to inspect a control element so that the air conditioner can operate. RFID (Radio Frequency IDentification) reader is preferred because of the low cost of the control element that will activate the air conditioner and it can be carried easily by the authorized teaching staff. Authorized teaching staff not located beside RFID card can control the air conditioner with his/her mobile device. It is enough that the mobile device that provides the control has the bluetooth connection feature.

Energy control of a saloon type air conditioner, 13.000W cooling and 14.060W heating capacity and 3 phase powered, is provided by a developed Arduino based control card. This control is provided with two methods. The first method uses an RFID card and the other method uses a mobile device with a Bluetooth connection. In the first method, the authorized person reads the RFID card control panel and allows the air conditioner to operate during the class time. In the other method, the authorized person provides a Bluetooth connection between the mobile device and the control card and thus controls the energy of the mobile device via the RemoteXY software. With the help of sensors that measure the outdoor humidity and temperature values, it is decided that the same platform air conditioner should work.

The climate control card we developed uses the Arduino nano platform, the RC522 RFID card reader, the DHT-22 sensor to measure humidity and temperature, the single channel relay board to supply contact energy, and the HM-10 module to establish a Bluetooth connection with mobile devices.

Arduino Nano Platform

The Arduino Nano platform is an open source hardware platform with dimensions of 19x43mm and has the Atmega328 microcontroller. On this platform there are oscillator circuit which determines the operating frequency of the microcontroller, supply regulator circuit that provides the operation and necessary circuit for serial communication with the computer. The existence of these circuits helps the user to develop the project easily without having advanced electronic knowledge (Banzi M., 2011: 17-19)

The Arduino Nano platform has 13 digital input / output ports (pins starting with D) and 8

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analog input ports (pins starting with A) (Figure 2).

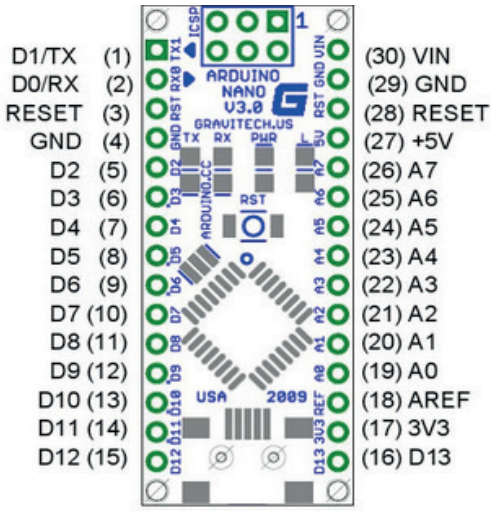

Figure 2. Arduino Nano Platform Pin-Up Top View

RC522 RFID Reader - Mifare Card – Key Cahin Module

RFID (Radio Frequency Identification) technology is a technology that can be applied in many sectors and is rapidly developing in wireless communication technologies. This technology basically consists of a reader, a tag and an antenna connected to them. The information on the label is read or written via radio frequency. In this way, the tags that are placed or carried in the objects are used to store and control the information in many areas. RFID technology can be integrated with other wireless technologies. If we look at its development, there is hope for the future. RFID is used mainly in supply chains, logistics, security, health, animal husbandry, library, education and so on. It is a feasible technology in many fields (Marasli F. and Çıbuk M. 2015: 1).

The RC522 RFID reader, mifare card and keychain module we use in our work are shown in Figure 3. The RC522 RFID reader is used to transfer the ID information from the Mifare card or keyring module to be read via the SPI (Serial Peripheral Interface) communication protocol to the Arduino Nano.

Figure 3. RC522 RFID Reader-Mifare Card–Key Cahin Module

The RC522 RFID module is capable of communicating with the Arduino Nano platform via SPI, I2C and UART communication protocols (Figure 4).

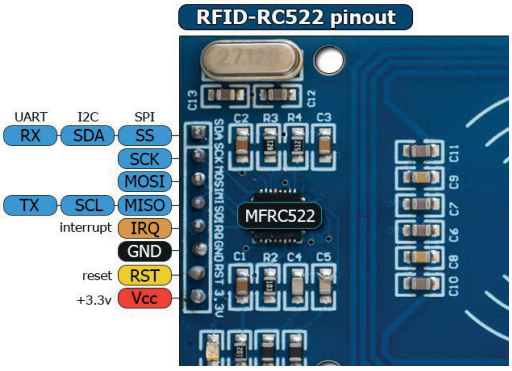

Figure 4. RC522 RFID Reader Pinout

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DHT-22 Sensor

The DHT-22 sensor (Figure 5) consists of two parts; capacitive humidity sensor and thermistor. Thanks to the embedded chip, analog signals are converted into digital signals. Thus, the generated digital signals can be easily read by microcontrollers. DHT-22, a simple but slow-running sensor, is often preferred due to its low cost by hobbyists (https://learn.adafruit.com/dht).

The DHT-22 sensor is used to obtain humidity and temperature information for indoor and outdoor environments.

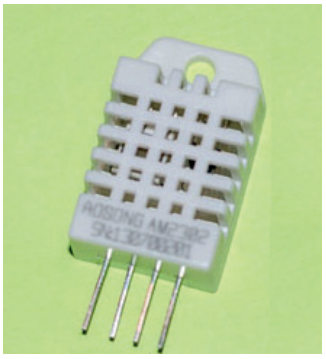

Figure 5. DHT-22 Sensor

Single Channel Relay Board

The single channel relay control card is a relay card that can be used with Arduino or other microcontrollers where the contacts can be controlled by 5V. For the relay, pins are taken out NC (Normally Closed), NO (Normally Open) and COM (Common). Thus, it can be used in short-circuit in case of trigger or open circuit in case of trigger. It can switch the current up to 10 Amperes at 220VAC voltage (Figure 6).

During the trigger signal coming through the Arduino Nano platform, a current of 20mA is drawn and the coil is energized to change the position of the contacts. Thus, the three-phase contactor which will give way to the saloon type split air conditioner is energized.

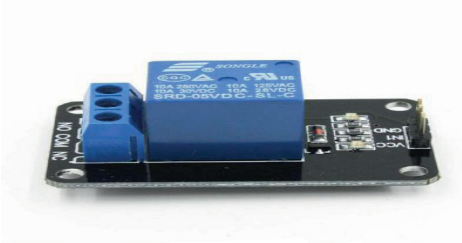

Figure 6. Single Channel Relay Board

HM-10 Bluetooth Module

Although the HC-05 and HC-06 bluetooth modules are popular, they are ineffective in providing control over mobile devices with Android and IOS operating systems. These modules use the Bluetooth 2.0 standard and are only able to pair with mobile devices running the Android operating system. However, the new generation of mobile devices support Bluetooth 4.0 (Bluetooth Low Energy- BLE). For this reason, the HM-10 Bluetooth module shown in Figure 7, which uses the Bluetooth 4.0 standard, is preferred in our project.

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Figure 7. Bluetooh Module (HM-10)

CONCLUSION

Using the above-mentioned electronics materials, the control card with the circuit diagram shown in Figure 8 is designed. The 3 phase supply of the air conditioner is connected to a 3 phase fuse. Then the 3-phase contactor is connected and the control is provided with the relay so that the energy path is opened or closed.

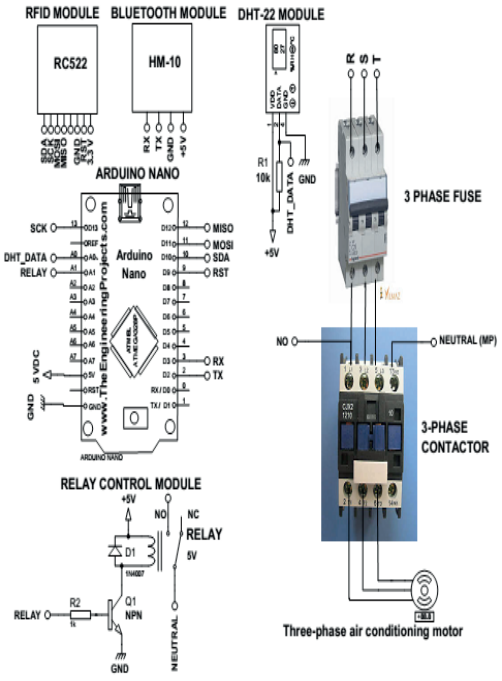

Figure 8. Control Card Scheme

In order to the user to provide climate control, it is necessary to establish a connection between Bluetooth on the mobile device and the HM-10 bluetooth module on the climate control card. After the bluetooth connection has established, the air conditioner power can be controlled via the mobile device.

The mobile user interface, shown in Figure 9a, is intended to inform the user how to use the control program when the program is run.

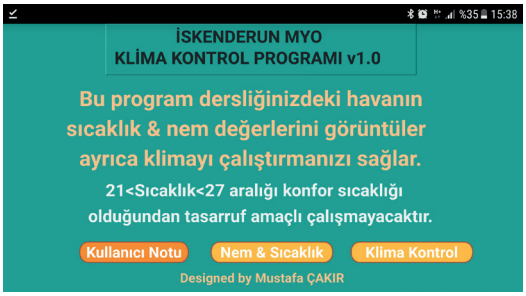

Figure 9a. Explanation About the Control Program

The image shown in Figure 9b is added so that the user can see the temperature, humidity, and operating time of the environment.

Figure 9b. View the Temperature and Humidity Values of the Environment and Remaining Time

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The image shown in Figure 9c provides the user with the ability to energize the climate and determine the duration of the operation.

Figure 9c. Determination of air Conditioning Operating Time

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